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We have employed three tasks, developed by cognitive psychologists to study attention, with a population of six brain injured subjects in a rehabilitation program. Each of the tasks had been validated by studies with unilateral stroke patients and appear to provide a means of examining the relative efficiency of the two cerebral hemispheres when demands upon them are placed in conflict. We found that five of the six patients had imbalances between the two hemispheres. Four of them met our definition of attentional because the imbalance interacted with cues. The results show that the three tests converge on a common picture of cerebral imbalances in these brain injury patients and may relate to some aspects of their normal functioning.

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ATTENTIONAL IMBALANCES FOLLOWING HEAD INJURY

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ATTENTIONAL IMBALANCES FOLLOWING HEAD INJURY:

A Preliminary Analysis of Six Patients[1]

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ABSTRACT

We have employed three tasks, developed by cognitive psychologists to study attention, with a population of six brain injured subjects in a rehabilitation program. Each of the tasks had been validated by studies with unilateral stroke patients and appear to provide a means of examining the relative efficiency of the two cerebral hemisphere when demands upon them are placed in conflict. We found that five of the six patients had imbalances between the two hemispheres. Four of them met our definition of attentional because the imbalance interacted with cues. The results show that the three tests converge on a common picture of cerebral imbalances in these brain injury patients and may relate to some aspects of their normal functioning.

Unilateral left and right hemisphere lesions produce numerous well documented neuropsychological consequences (DeRenzi, 1982). Some of these sequele are attentional (Nissen, 1986; Posner & Rafal, 1986), involving anatomical systems related to the selection of information for conscious detection. Such attentional deficits can often be demonstrated in tasks involving conflict between stimuli (Posner & Presti, 1987).

For example, patients with left hemisphere lesions have difficulty selecting a verbal input when it conflicts with a simultaneous spatial command. Patients with right hemisphere damage show the reverse pattern (Walker, Posner & Friedrich, 1983). Similarly, patients with parietal lobe lesions often have great difficulty when an event in the contralesional visual field is in conflict with one in the ipsilesional field. In severe cases these patients may be completely unaware of contralesional targets while in milder cases the target may be detected but with longer latency (DeRenzi, 1982; Posner, Walker, Friedrich & Rafal, 1984).

These findings from patients with focal unilateral lesions demonstrate the value of cognitive tests for the precise measurement of attentional deficits related to hemisphere imbalance (Posner & Rafal, 1986). The conflict tasks, for example, detect residual attentional imbalance well after standard neurological methods suggest that the patient's performance is normal (Posner, et al, 1984).

Clinical neurology has long used imbalances between the two eyes as a means of detecting subtle insults to the cranial nerves at the level of the midbrain (Mesulam, 1985). In recent years there has been much evidence of the specialization of the two cerebral hemispheres in the performance of higher level cognitive and emotional activity (Mesulam, 1985). It seems likely the imbalances between the two cerebral hemispheres, as reflected by cognitive tasks involving conflict may be of similar benefit in clinical neuropsychology. To explore this hypothesis it is of importance to measure these imbalances and to relate them to everyday behaviors likely to be differentially mediated by the two cerebral hemispheres.

It is now common for patients recovering from closed head injury to spend an extended period of time in a rehabilitation program, often supervised by a clinical psychologist. The opportunity for extended detailed observation of their classroom and extracurricular performance makes patients participating in such programs ideal subjects for relating attentional imbalances to disturbances in everyday behaviors.

As a step toward investigating this relationship, six patients undergoing therapy at the Head Injury Resource Center of Washington University were tested with several standard neuropsychological tests and three special attentional paradigms sensitive to attentional deficits in patients with unilateral lesions. We then examined clinical ratings of their academic performance and social interaction to determine if imbalances found in our tests might relate to aspects of everyday life involving attention. Because of the limited sample size this study serves primarily to provide validation of our tests to individual brain injured patients and as pilot data toward the goal of relating attentional imbalances to natural performance.

COGNITIVE ATTENTION TASKS

Covert orienting of visual spatial attention (Task 1) (Posner & Presti, 1987; Posner et al, 1984). This task involves the detection of a target stimulus (an asterisk) which occurs within one of two boxes located five degrees to the left or right of a fixation cross (Figure 1). Trials are either cued (80%) or uncued (20%). Cues consist of a brightening of one of the two peripheral boxes and remain present until target detection. The majority of cued trials (80%) are valid, with the targets occurring on the brightened side. The remaining 20% of the cued trials are invalid, with the target occurring on the side that is not brightened. Inter-trial interval is 1000 msec for cued and uncued trials. The interval between brightening of a peripheral box and target onset was either 100 or 800 msec for the cued trials (valid and invalid). Uncued targets occurred 1100 or 1900 msec following previous target onset.

Subjects received three blocks of 254 trials. Instructions were to fixate on the central cross and to press the single response key with the index finger of the dominant hand as rapidly as possible following target detection. Subjects were informed that most trials would be cued and that most cues would be valid.

Fig. 1

Covert Orienting of Spatial Attention with Central Cues (Task 2) (Posner, 1980; Posner, et al, 1984). The purpose of this task was to study orienting from central rather than peripheral cues. With the exception of cue location, the design was very similar to that of Task 1. Cues consisted of either a directional arrow (80% valid) or a neutral plus sign. Subjects were explicitly instructed to shift their attention, but not their eyes, in the direction indicated by the arrow. Targets followed cue onset at intervals of 100, 500, 800 or 1000 msec.

Selective Attention to Linguistic and Spatial Information (Task 3) (Posner & Henik, 1982; Walker, Friedrich & Posner, 1983). As described above, this task involves selective attention to a specified stimulus mode (spatial or linguistic). For each block, subjects were instructed to attend to one of two types of information (arrow or word). They had to press one of two keys depending on whether the instructed stimulus mode indicated 'left' or 'right'. The attended stimulus was presented in one of three conditions: either alone, with redundant information or conflicting information from the unattended modality. Redundant and conflicting stimuli were centered on the CRT and arrayed vertically (Figure 2). These three stimulus conditions were randomly mixed within a 96 trial block. Blocks were presented within an ABBA/BAAB design (A = attend arrow, B = attend word).

Fig. 2

Although never published, we had studied unilateral stroke patients on a task similar to 3, but never published the data (Walker, Posner & Friedrich, 1987). Since the current version was slightly different, we ran 12 normal subjects, six patients with unilateral right hemisphere lesions (from strokes) and three patients with unilateral left hemisphere lesions (from strokes) to validate our previous results. The results conformed well to our previous findings and are shown in Table 1. For the normal subjects, there was no significant difference in RT between the attend arrow and the attend word instructions and the two conditions yielded approximately equivalent interfering effects when placed in conflict. In contrast, the patients with right hemisphere lesions were slower and made many more errors when attending to an arrow in the conflict situation than when attending to the word. Several found the conflict task so difficult that they responded incorrectly (i.e. on the basis of the conflicting stimulus mode) more than correctly. The left hemisphere damaged patients showed good performance on the arrow condition, but were very slow and made many errors in the word condition. Errors were most common in the word condition. Despite the small sample size, these findings were confirmed with parametric statistical tests.

Table 1

SUBJECTS

Subjects were six clients, four male and two female, recruited from the Head Injury Resource Center. All subjects received a formal neuropsychological evaluation as part of the admissions procedure. All were involved in an intensive program of daily therapy and rehabilitation. Both formal neuropsychological and less formal treatment notes were thus available for comparison with cognitive test results. Demographic information pertaining to the six subjects is presented in Table 2.

Table 2

Group Data

The brain injured subjects were compared to twelve normal controls on tasks one and three. The group data for these tasks are shown in Figures 3 and 4.

Figure 3 displays median reaction times in Task 1 for valid and invalid trials at the 100 msec cue to target interval. Contamination of the data by eye movements is impossible at this short delay. Non cue trials are from the two delays combined. Inspection of the control data reveals the expected pattern, with valid cues facilitating performance in comparison to invalid cues in both visual fields. The most striking aspect of the grouped head injury data is how closely it resembles the normal pattern. Although slower than controls by approximately 100 msec, the head injured subjects generate the expected pattern of facilitation and inhibition.

Figure 4 shows group data for the arrow/word decision (Task 3). Control subjects tend to respond faster to an arrow than to a word and show slightly, but not significantly, more interference of the arrow in the attend word conflict trials than of the word in the attend arrow conflict trials. This pattern is replicated in a slower and exaggerated fashion by the head injured subjects.

Fig. 3,4

Although many studies have considered patients with closed head injury as a homogenous group, it is clear that differences due to lesion size and location may affect task performance. Combining the data of our six subjects is misleading because differences between subjects are obscured by averaging. It is not surprising then that the resulting pattern differs only in speed from that of healthy controls. It is more useful to look at the patterns of performance of the three tasks in individual subjects, and to attempt to relate these patterns to neuropsychological and observational parameters.

Individual Subjects

Individual patient scores for the three cognitive tests are given in Tables 3, 4 and 5. To simplify the presentation we again present reaction times for valid and invalid trials at the 100 msec interval only. The results for each subject are discussed individually below.

Subject 1: Subject 1 shows a pattern of attentional deficits that is consistent across the tasks. At the 100 msec delay, Subject 1 shows a pattern of covert orienting on Task 1 very similar to that seen in patients with left parietal lesion (See Table 3). This pattern is characterized by particular difficulty in shifting attention contralesionally when there has been an ipsilesional cue. It is reflected in very long reaction times to invalidly cued targets in the right visual field. On Task 2 (Table 4), Subject 1 is slower to respond to targets in the right visual field at the 100 msec delay. In addition, the validity effect appears to be larger for right than left sided targets.

Subject 1 evidences a large advantage of the arrow over the word on the task of selective attention (Table 5). Moreover, the word shows a much larger interference effect from the arrow in the conflict condition than the arrow shows from the word.

In summary, the cognitive tests converge to suggest that subject 1 may have an attention deficit that is left hemisphere predominant. Neuropsychological test results are consistent with this hypothesis. In particular, performance on language measures tapping naming, comprehension, and repetition are well within the aphasic range, indicating significant left-hemisphere dysfunction. Lateralizing measures were somewhat more suggestive of left than right hemisphere dysfunction. Additionally, clinical observations are notable for problems caused by poor memory, inflexibility, and concreteness. These problems are most severe when they interact with linguistic demands. It is worth noting that memory problems were accompanied by confabulation when the patient first entered the program. In addition to the effects on recent memory, the patient's basic fund of knowledge (semantic memory) and remote memory for events (episodic memory) were both impaired. For example, he was sometimes unable to demonstrate any knowledge about the characteristics or uses of familiar objects, and he was sometimes unable to remember significant events in his life as far back as his childhood. Although memory had improved substantially by the end of treatment, evidence of intrusion was still present on formal testing. Subject 1 was consistently unaware of the extent of his deficits and particularly their implications. Interestingly, on the other hand, he shows a strength in his ability to maintain a focus of attention in structured and repetitive tasks, and this proved to be an asset vocationally for him.

Subject 2: Subject 2 obtains a pattern of cognitive test results that is almost the opposite of Subject 1 and appears to exemplify a right hemisphere attentional imbalance. This effect is rather weakly demonstrated on Task 1 (Table 3) in which the left visual field is systematically worse than the right only in the invalid condition, but the trend is confirmed on Task 2 (Table 4) where performance is generally worse in the left visual field. Subject 2 is the only subject for whom word processing on Task 3 is faster than arrow processing (Table 5). Interference effects appear to be approximately equal for the arrow and the word.

In spite of severe bilateral injury on acute CT scans, neuropsychological test results are most consistent with the right hemisphere deficit hypothesis suggested by the cognitive tasks. Subject 2 obtained a WAIS-R Performance IQ 15 points below his Verbal IQ of 113. Of note, finger tapping is within normal limits for the right index finger but severely impaired for the left. Informal observations, in fact, suggest that subject 2's areas of greatest functional impairment are not in attention but in organization and memory. Although memory tests were generally within normal limits by the end of the program, the pre-program testing had shown a pattern consistent with a consolidation deficit in verbal memory. It is of further interest that Subject 2 often remembers a fact or happening but cannot associate such information with the context in which it occurs. He has difficulty recognizing the memory problem and the implications of this problem, and thus, is not consistent in compensating for this deficit. Finally, he is often noted to show irritability and difficulty with temper control.

Subject 3: Subject 3 shows the most complex pattern of the head injured group on cognitive testing. On Task 1 (see Table 3), Subject 3 was slower to respond to invalid stimuli in the left visual field. On closer inspection, however, the advantage of cues for targets in the left visual field appears to be normal. Targets in the right visual field, in contrast, failed to show a validity effect at the 100 msec delay. Task 2 data (Table 4) provide confirmation of a left rather than a right hemisphere deficit, as detection of right visual field stimuli is much slower than of left visual field stimuli, especially for invalid trials. Performance on the arrow/word task further supports a left hemisphere attentional imbalance with slower processing for the word and a greater interference effect of the arrow (Table 5).

Neuropsychological data for Subject 3 are consistent with the cognitive test results. Although not grossly aphasic, Subject 3 shows deficits in many realms of verbal functioning. Like Subject 1, he was impaired in naming and auditory-verbal comprehension, and is especially impaired with repetition. Phoneme and rhythm discrimination were also notably disturbed. There was a right homonymous hemianopsia and indications of a right visual neglect. Although the left-hemisphere injury is obvious from testing, it is worth noting this subject had a partial right temporal lobectomy. During functional activities in therapies, he does show slowed ability to learn secondary to verbal memory and auditory processing deficits. Yet, this patient demonstrates good nonverbal skills, excellent orientation to his surroundings, and good interpersonal/social skills. In spite of comparatively severe deficits, he demonstrates strengths in his awareness of and ability to compensate for deficits.

Subject 4: Subject 4 shows slightly longer RTs toward stimuli in the left visual field at 100 msec on Task 1 (Table 3). In addition, the data reveal difficulty in orienting attention to the left side (no validity effect). Task 2 also reveals a reduced validity effect on the left (Table 4). These results suggest a right hemisphere deficit that involves attention. Data from the arrow/word task (Table 5) show a minimal advantage of spatial over linguistic processing and the symmetric nature of the interference effects are compatible with a slight deficit in right hemisphere processing.

While neuropsychological testing of Subject 4 indicated there was some evidence of anterior left hemisphere dysfunction (i.e., Visual Naming and Controlled Oral Word Association were below the 12th percentile), the pattern was generally supportive of right hemisphere predominant dysfunction. For example, her performance IQ was 13 points below her verbal IQ of 91. Although Subject 4 showed a relative strength in Block Design, she demonstrated deficits in attention to visual detail, visual sequencing, puzzle construction, and psychomotor speed. During initial evaluation, she also demonstrated a scanning deficit, omitting items on the left side of the page. These results are consistent with the left frontal injury caused by depressed skull fracture and the posterior right hemisphere contusion visualized on the CT scan. Clinically, residual visual-spatial deficits were apparent in affecting her attention to surroundings and her ability to integrate visual details into an organized whole. Difficulties were also present in mental flexibility, concreteness, interpretation of nonverbal signals, and comprehension of subtleties/humor. Additionally, Subject 4 demonstrated lack of awareness of the deficit areas, as well as their implications in her life. Like Subject 1, Subject 4 was able to sustain attention during structured tasks.

Subject 5: Subject 5 stands out on Tasks 1 and 2 in showing a slower RT to left visual field stimuli, thus a right hemisphere deficit that does not interact with cue type and thus does not appear to be attentional in our sense. Performance on Task 3 was better for the arrow than for the word alone. In addition, while word processing was considerably slowed by the presence of conflicting arrows, arrow processing was largely uninfluenced by the presence of conflicting words.

Subject 5 showed very few deficits on formal neuropsychological evaluation, and has obtained a Bachelor of Science Degree since her injury. Fine motor coordination was slow bilaterally, more so for the left hand than for the right. The most striking aspect of the neuropsychological examination was a severe deficit on the Tactual Performance Test with the left hand. This latter pattern of performance is generally considered to be suggestive of right parietal dysfunction. Clinically, Subject 5 was characterized by susceptibility to distraction, concreteness, and impulsivity. Her most severe functional deficits, however, were in the areas of social and interpersonal skills, including difficulty recognizing the emotions of others and monitoring appropriate verbal output. Additionally, Subject 5 was unaware of her deficits and their implications into her life. She also was characterized by an inability to experience negative affect. This reduced the likelihood that effective response to confrontation would result in behavior change.

Subject 6: Subject 6 shows no evidence of imbalance. Performance on the two spatial orienting tasks is largely symmetric. Reaction times for

Task 3 are faster for the arrow than the word alone. Arrow processing, though, was inhibited in both redundant and conflict conditions by the presence of the word while word processing was facilitated by the arrow in the redundant condition and inhibited by the arrow in the conflict condition.

In contrast to the weak results on cognitive testing, neuropsychological test results from Subject 6 are compatible with a deficit that is right hemisphere predominant. This is most strikingly indicated by a significantly lower Performance IQ, as compared to Verbal IQ. Testing revealed both verbal and nonverbal memory deficits, with great visual memory impairment apparent than verbal. This pattern of memory impairment would be consistent with the right temporal lobe atrophy on CT scan, although this atrophy may have preceded the injury. Left hand finger tapping was mildly impaired in comparison to the right. Clinically, attentional problems were evident, including attention to detail, attention to surroundings, and concentrating on several items simultaneously. Additional difficulties were observed in organization, integration of the parts into the whole, and in recognition of faces. Subject 6 demonstrated excellent awareness of his deficit areas, as well as good ability to compensate for them.

DISCUSSION

The goal of this project was twofold: 1) to determine if attentional imbalances could be measured in head injured patients using cognitive tasks; and 2) to relate attentional imbalances between the hemispheres to formal and less formal neuropsychological measures. Although our small sample size precludes firm conclusions, several interesting findings emerged.

Hemispheric imbalances were found in five of the six brain damaged subjects (all but Subject 6) suggesting that such imbalances may be quite frequent following closed head injury. In our sample, four of the patients with hemispheric imbalances probably had an attentional component to their deficit as evidenced by an interaction between cue type and hemispheric asymmetry on the tasks of covert spatial orienting.

Performance on the arrow/word attention task was consistent with the covert orienting task in all four subjects with attentional imbalances. We treated the arrow/word task as attentional because the unilateral patients (see Table 1) had so much more trouble in the conflict situation. An alternative is that the deficit arises in the difficulty of patients in processing the word or arrow condition even when it is not presented with conflicting information. This appears to be particularly true of patient 3.

These attentional imbalances occurred in the presence of bilateral injury in all four cases. Some factor such as the comparative location or volume of injury most likely accounts for the imbalance. The presence of both right and left hemisphere imbalances in different patients further demonstrates the importance of considering each patient individually rather than as a homogenous group.

These preliminary data raise the issue of whether the imbalances found in the cognitive task are greater than one might expect from the normal population. We have only a little data on this issue. Three of the patients had an imbalance based primarily upon right-left differences in the invalid cue condition of Task 1. These differences are 132, 74 and 48 millisec respectively. Of thirty normal subjects run in this test only three had differences in this condition as large as 50 millisec. At least two of the patient values do seem quite large to be normal. One subject was diagnosed primarily on the lack of a validity effect in one field but not the other. This pattern was detected in only three of our 30 normals. Finally, one patient was diagnosed largely on the reversal of the normal pattern in the arrow/word study and this pattern was larger than we found in any of the twelve normals studied. These findings suggest that the differences found in our patients were the result of the cerebral injuries but further work would be necessary to establish the general validity of the testing methods.

Two of the four patients with attentional imbalance were hypothesized to have greater left hemisphere dysfunction. Both performed well within the aphasic range on several language parameters, and had neuropsychological evaluations consistent with a primary left hemisphere deficit. The remaining two patients with attentional imbalances on cognitive testing were hypothesized to have predominant right hemisphere dysfunction. In addition to other neuropsychological indications of a primary right hemisphere deficit, both patients suffered from social/emotional adjustment problems and depression. A third subject with evidence of greater right hemisphere dysfunction without an imbalance (Subject 5) suffers from serious social and interpersonal difficulties. This relation may suggest an important link between the imbalance found in cognitive tasks and observational ratings of behavior and personality during therapy.

Our three tasks appear to converge on the side of primary deficit in most of the head injury patients. In addition, it appears that they relate well to patterns of lateralization in neuropsychological evaluation. It remains to be determined if these tests provide a sufficiently sensitive measure of imbalances to be useful as a tool for diagnosis and recovery. In addition, we need to know much more about the relationship of such imbalances to performance outside the laboratory.

A useful step would be to relate performance on cognitive tasks over time to neuropsychological and functional measures of recovery. There is some evidence (e.g. Morrow & Ratcliffe, 1987) that the size of the validity effect on the peripheral orienting task correlates with clinical recovery from left sided visual neglect. Replication and expansion of this result would serve as further evidence for the usefulness of simple cognitive measures in the evaluation of attentional deficits and their remediation.

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FIGURE CAPTIONS

Figure 1. Cue conditions for Task 1. Valid trials are ones in which the target occurs on the cued side. Invalid trials are ones in which the target occurs on the opposite side of the cue.

Figure 2. Stimulus conditions for arrow/word task.

Figure 3. Mean Reaction Time as a function of cue condition for Task 1. Data are from valid, invalid and no cue trials for 6 closed head injury patients and 12 normal controls. All cued data are from the 100 msec cue to target condition.

Figure 4. Mean Reaction Time as a function of condition for Task 3. Data are for 6 closed head injury patients and 12 normal controls.

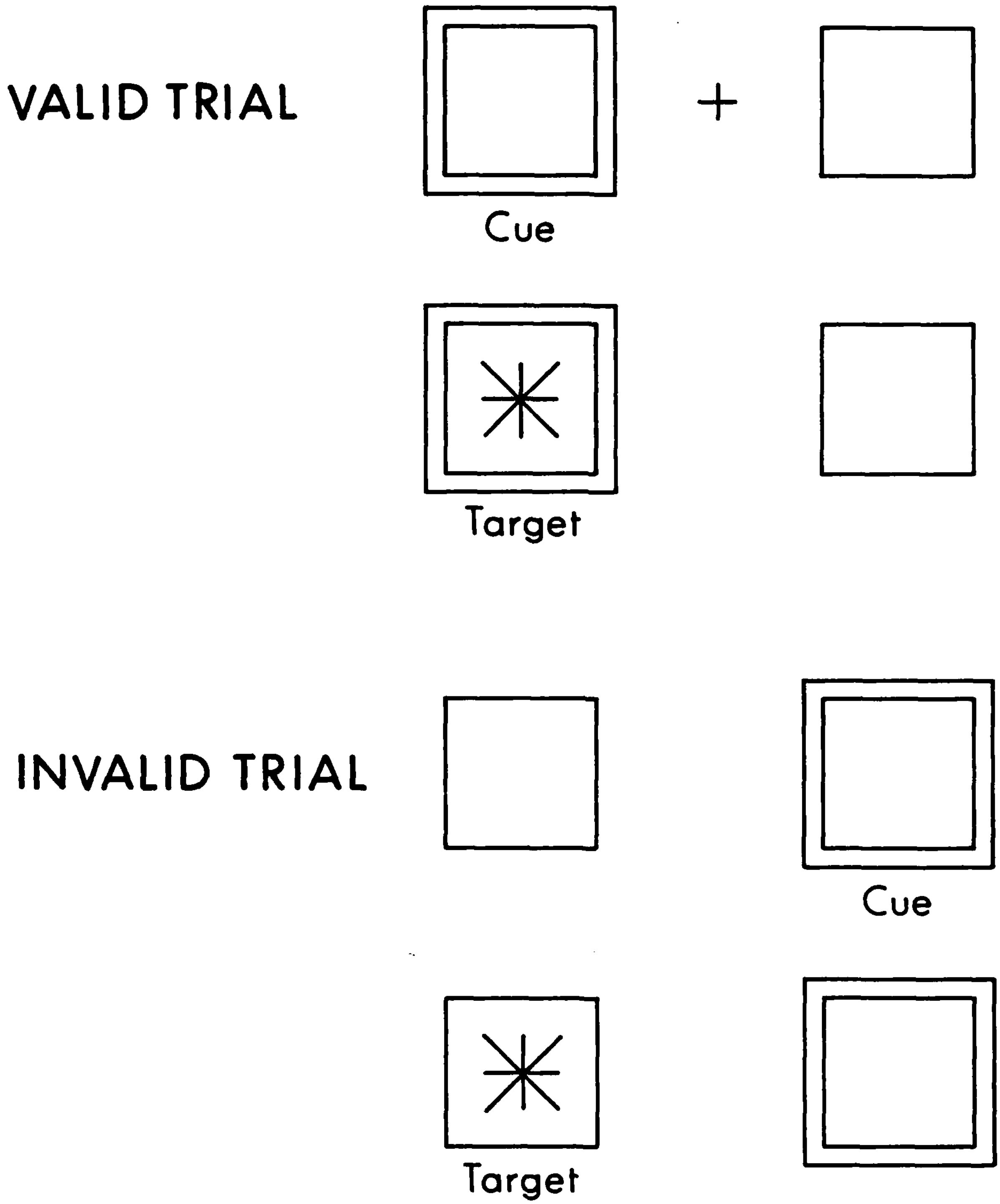
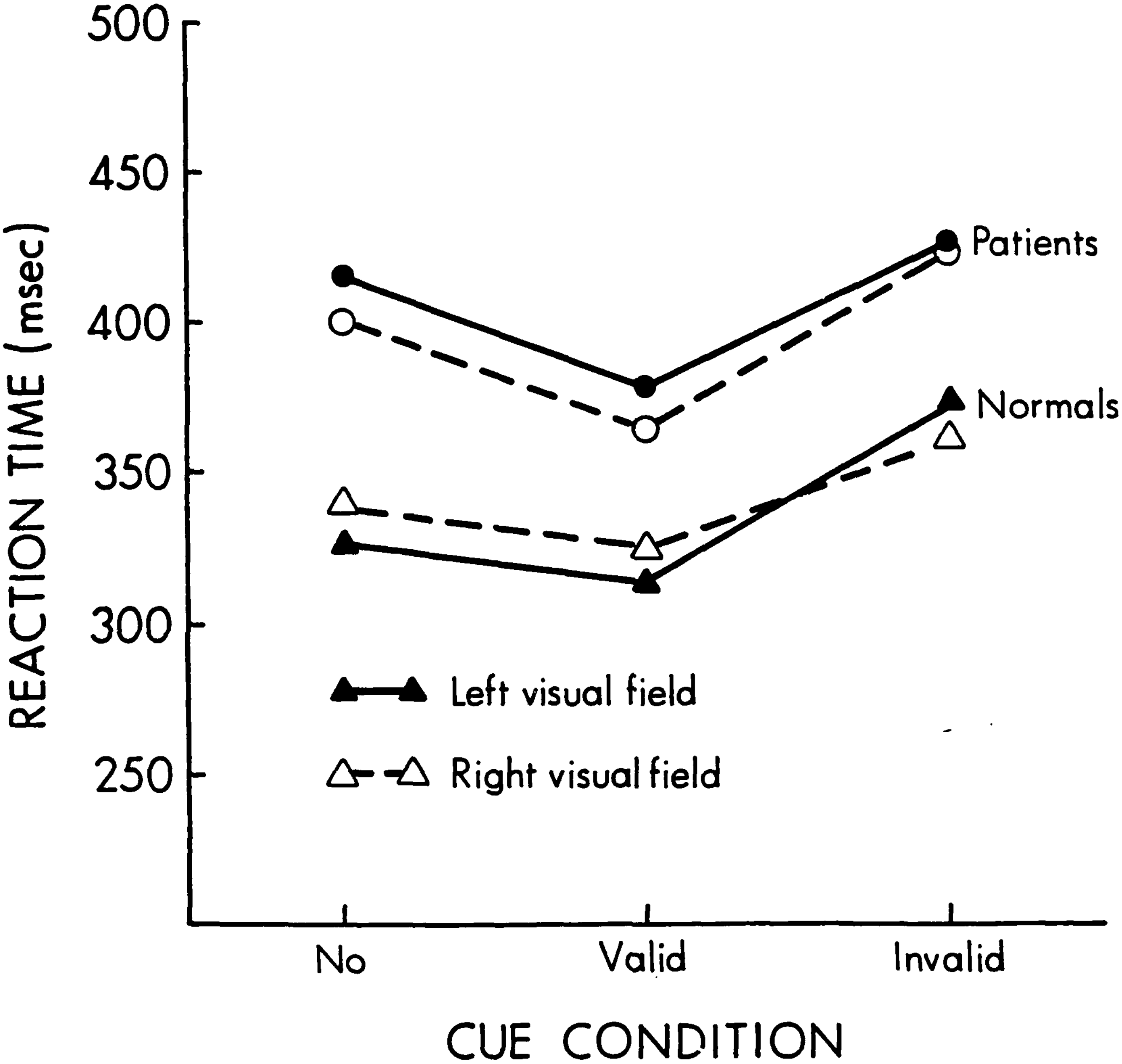

VALID TRIAL
Cue
Target
INVALID TRIAL
Cue
Target

FIGURE 2

	Alone	Redundant	Conflict
Attend Arrow	→	→ Right	Left ←
Attend Word	Right	Right →	Right ←



500
450
400
350
300
250
REACTION TIME (msec)
Patients
Normals
Left visual field
Right visual field
No
Valid
Invalid
CUE CONDITION

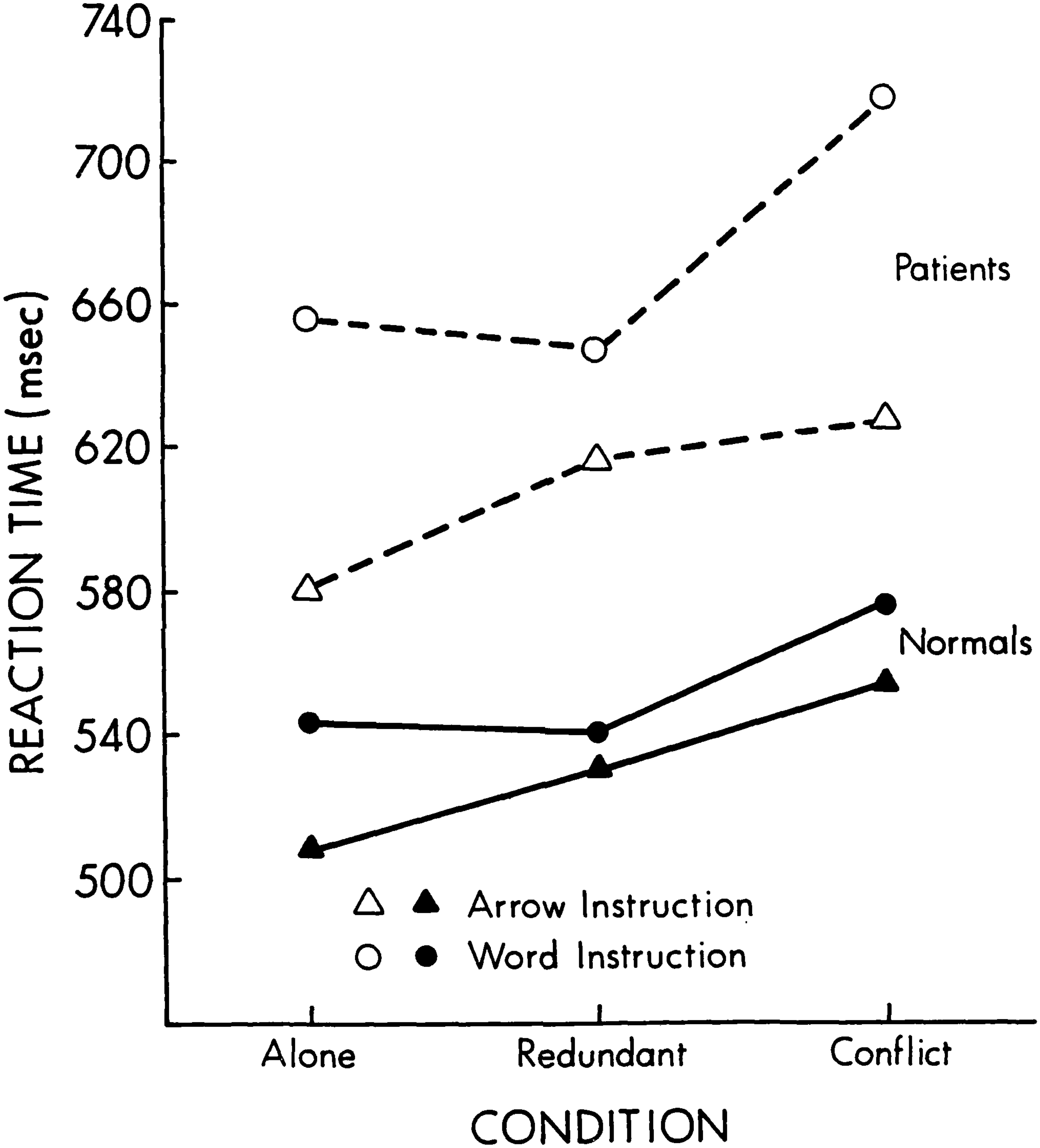

740
700
660
620
580
540
500
REACTION TIME (msec)
Patients
Normals
Arrow Instruction
Word Instruction
Alone
Redundant
Conflict
CONDITION

TABLE 1

Mean Reaction Times (and Percentage Errors)

for the Arrow/Word Task

	ARROW			WORD		
	ALONE	REDUNDANT	CONFLICT	ALONE	REDUNDANT	CONFLICT
RH N=6	700 (10.2)	800 (4.7)	878 (43.5)	738 (5.3)	760 (2.3)	801 (2.9)
LH N=3	591 (5.6)	666 (5.2)	654 (6.5)	666 (5.2)	652 (1.0)	748 (28.3
CONTROL N=12	507 (0.5)	533 (0.5)	558 (3.1)	541 (1.8)	541 (0.8)	575 (3.3)

TABLE 2

SIX HEAD INJURED SUBJECTS

	GENDER	AGE	EDUCATION	TIME POST ONSET	SENSORY DEFICIT	NEUROLOGICAL INFORMATION
1.	M	28	12	1 Year	-color blind -right ear -conductive hearing loss -impaired visual tracking with left eye in nasal direction	-rt. frontal hemorrhage -EEG showed abnormal LH activity -lengthy period of post traumatic amnesia and agitation generalized cerebral
2.	M	20	12	18 months		-hemorrhage in left sylvian fissure -lucency in left peripheral thalamus + left temporal lobe -lucency in right basal ganglia -craniotomy with evacuation of right temporal hematoma
3.	M	24	12	1 year	-right homonymous hemianopia	-left occipital skull fracture -diffuse region of low density in left temporal/parietal occipital area -region of low density in right frontal lobe -right temporal contusion with craniotomy -left to right midline shift
4.	F	24	16	9 months		-depressed left frontal skull fracture -left frontal contusion -right occipital/ parietal contusion -left frontal craniotomy with with debridement
5.	F	24	16	9 years		-bilateral intracerebral hematomas -frontal & basal ganglia contusions -right frontal subdural hematoma
6.	M	57	14	2 1/2 yrs.	-5th, 6th, 7th nerve palsy	-basilar skull fracture -right temporal lobe atrophy

TABLE 3

Median RTs (msec) for Brain Injured Subjects in Task 1
As a Function of Visual Field and Validity
(100 Millisec Interval)

Subject	VALID		INVALID	
	Left	Right	Left	Right
1	422	440	458	590
2	370	380	455	431
3	412	432	504	430
4	637	593	629	621
5	380	322	395	347
6	344	343	421	398

TABLE 4

Median RTs for Brain Injured Subjects in Task 2
As a Function of Visual Field and Validity
(100 Millisec Interval)

Subject	VALID		INVALID	
	Left	Right	Left	Right
1	596	631	652	704
2	403	392	441	404
3	504	567	576	783
4	581	512	608	560
5	476	417	545	492
6	373	382	409	388

TABLE 5

Median RT and Number of Errors ( )
for Brain Injured Subjects in Task 3
as a Function of Condition and Conflict

	ARROW			WORD		
	Alone	Redundant	Conflict	Alone	Redundant	Conflict
1	514 (1)	570 (2)	581 (1)	658 (4)	659 (2)	736 (11)
2	586 (1)	602 (1)	627 (2)	531 (0)	544 (1)	555 (1)
3	609 (1)	634 (0)	647 (0)	902 (0)	868 (0)	978 (2)
4	642 (0)	671 (0)	688 (1)	671 (0)	679 (0)	708 (0)
5	557 (1)	589 (0)	585 (3)	596 (0)	562 (0)	671 (3)
6	563 (0)	632 (0)	628 (5)	614 (1)	598 (0)	629 (0)

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